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Factors Affecting the Adoption of Agroforestry Practices by Farmers in Cameroon

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This paper presents empirical evidence on the impact of socio-economic factors on the adoption of agroforestry practices in Cameroon. The analysis uses primary farm-level data collected from June to December 1996. Three major provinces of the country were covered, namely Centre, Southwest and Northwest. Several agroforestry technologies have been promoted among farmers in the zone, including alley farming, improved fallow, live fencing, cut-and-carry fodder and apiculture. The status of adoption of each agroforestry practice is described and factors that affect adoption identified. These are gender of farmer, household family size, level of education, farmer's experience, membership within farmers' associations, contact with research and extension, security of land tenure, agroecological zone, distance of the village from nearest town, village accessibility and income from livestock. Research findings indicate that since factors affecting farmers' adoption of agroforestry practices differ across techniques, generalisation is to be avoided.

Keywords: Agroforestry, adoption, econometric analysis, socio-economic characteristics, logit model

INTRODUCTION

Many developing countries will need to double their food production by 2020 if they are to successfully feed their burgeoning populations (Hazell 1995). This will require maintaining, if not increasing, current rates of growth in national food production in sustainable ways that do not degrade the natural resource base. The continued threat to the world's natural resources is exacerbated by the protracted poverty and food security crisis in sub-Saharan Africa (SSA) where per capita food production continues to decrease (Sanchez *et al*. 1998). Africa also ranks first in human population growth rates (2.9% per year), in the number of malnourished children, in the proportion of arable land that is degraded, and in poverty, with half its population living on per-capita incomes of less than one US dollar per day (World Bank 1995).

Agriculture in SSA is characterised by slash-and-burn systems wherein farmers use fallow to restore soil fertility. Historically, farmers were able to use long fallow periods to sustain food production under slash-and-burn systems, but rapid growth in population and land-use pressure have led to a reduction of fallow duration below the threshold required for the system to be sustainable (Nkamleu 1999a). Facing declining land productivity, farmers have adjusted by expanding cultivation into marginal lands and bringing new forest areas under slash-and-burn cultivation, with negative environmental effects. Nutrient cycling is also much reduced under slash-and-burn systems because the majority of the nutrients normally built up in the vegetation during the fallow period are immediately lost when the vegetation is burnt (Nkamleu 1999b). Unless properly managed, slash-and-burn agriculture can lead to negative environmental consequences of deforestation, carbon loss, loss of aboveground and belowground biodiversity (Gockowski *et al*. 2000), increases in pest and weed infestation, and a decline in soil fertility.

One alternative to the slash-and-burn system is agroforestry (Spencer 1986, Kang *et al*. 1995). Indigenous agroforestry practices are already widespread in Africa, as well as the planting and protection of many tree species introduced during the colonial period and later through forestry and agroforestry extension projects (Franzel and Scherr 2002). However, most are not suited to meet SSA's agricultural challenges.

Franzel and Scherr (2002) reported that as early as 1989, as many as 60 development projects promoting agroforestry in Africa were identified. Despite this impressive presence, agroforestry projects are known to suffer from inadequate rates of adoption and abandonment soon after adoption (Patanayak *et al*. 2003) Many researchers have lamented the fact that adoption and diffusion have lagged behind scientific and technological advances in agroforestry research, reducing the potential impacts of agroforestry-based development projects (Adesina *et al*. 2000, Mercer 2004). As argued by Patanayak *et al*. (2003), this situation explains the concern of researchers and policy-makers to see more socioeconomic research on agroforestry, and the development of predictive understanding of how farmers make decisions regarding agroforestry.

Although a substantial amount of literature on agroforestry adoption has been published over the past 10 years (Mercer 2004), many of the studies concern limited geographical areas (Patanayak *et al*. 2003), making it difficult to draw general conclusions. Different incentives, institutional mechanisms, and policies could be implemented to facilitate agroforestry adoption, according to the specificities of the area. Unfortunately, in some areas and countries, including in Cameroon, information on the influence of policy factors on the adoptability and performance of agroforestry practices is scarce (Adesina *et al*. 2000), which makes it difficult for policy-makers to implement proper interventions.

The objective of the research reported here is to determine the factors that affect farmers' adoption of agroforestry technologies in Cameroon. Several types of agroforestry technologies have been promoted in the zone, including alley farming, improved fallow, live fencing, cut-and-carry fodder and apiculture. Extension activities on agroforestry practices were conducted by research and development agencies including the World Bank-funded National Agricultural Extension and Training Program, Peace Corps volunteers, and the Centre for the Environment and Rural Transformation. The rest of the paper is divided into five sections: the survey,

the analytical model, data and the empirical model specification, the results, and the conclusion.

AREA DESCRIPTION AND SURVEY METHODOLOGY

The survey on which this paper is based is the most extensive carried out to date on the adoption of agroforestry in Cameroon, and was conducted from June to December 1996. More than 800 farmers were surveyed in three major agroecological zones, the humid forest (Centre province), the coastal humid forest (Southwest province), and the highland savannas (Northwest province). These study areas were selected to capture important variations in population pressure, soil fertility gradients, market access and rural infrastructure, customary land-use systems and production systems.

The humid forest zone of the Center province is characterised by primary and secondary forests, and fields under short fallow dominated by bush vegetation. The Beti are the predominant indigenous ethnic group and consist of the Ewondo, Eton, Bulu and Bassa.

Southwest province is located in the coastal humid forest agroecological zone, which is characterised by high rainfall, ranging from 1800 to 9800 mm. There are 18 ethnic groups, with migrants (mainly from Nigeria and the Northwest province) accounting for 30% of the population.

The Northwest province has the highest level of population pressure, which is as high as 200 persons/km^2 in particular areas. The province is divided into two ecological zones based on altitude. Mid-altitude areas have elevations ranging from 1000 to 1500 masl while highland areas have elevations of 1500 to 2500 m and more. There are four major ethnic groups in the province, namely the Widikum, Tikari, Chamba and Fulani.

Selection of the farmers in each of the provinces followed a stratified random sampling procedure. For each of the provinces, an exhaustive list of villages where there had been agroforestry project interventions was developed. The list was prepared with the assistance of agroforestry-oriented NGOs, extension services and researchers. From this list, a random sample of 41 villages was drawn and 30 farmers were randomly selected in each village from a list of farmers in the village.

Each of the villages was geo-referenced and characterised in detail, in terms of population, market access, fallow length, erosion situation, fuelwood availability, importance of livestock, fodder supply situation, and presence of agroforestry-related research, extension and NGOs. A questionnaire was developed and tested through interviews of farmers, after which minor revisions were made. Using the final questionnaire, farmers in the sample were personally interviewed on their use of agroforestry practices, constraints to use, land and tree tenure, tree preferences, perceptions of agroforestry, and management of plots. Some of the farmers selected in each village declined to participate in the survey. Overall, the final database from the survey comprises 820 respondents, including 341 in the Northwest province, 256 in the Southwest province, and 223 in the Centre province.

Two methods were used to collect data in the villages. *Focus group discussions* were used to elicit from farmers the history of land use and deforestation in the villages, fallow management practices and other methods of soil fertility maintenance, land tenurial arrangements, the history of village involvement (if any)

in on-farm or demonstration trials on agroforestry practices, the importance of livestock, resource scarcities (i.e. fuelwood and fodder, and the extent of soil erosion. In the *farm survey*, primary data were collected from individual farmers on their adoption or otherwise of agroforestry on their plots. The major agroforestry practices covered in the survey were alley farming, improved fallows, live fencing, apiculture and cut-and-carry fodder systems. Definitions of agroforestry practices concerned are provided below and are based in part on Swinkels and Scherr (1991):

Alley farming: Leguminous trees are grown in rows in cropland with regular spacing between the rows. The trees are intensively managed by being cut back at frequent intervals.

Improved fallows: Trees are planted on fallow fields to maintain or improve soil fertility and to provide products that increase the economic value of the fallow. The trees are generally harvested at the end of the fallow period.

Live fencing: Lines of trees or shrubs are planted on farm boundaries or on the border of home compounds, pastures, fields or animal enclosures. Their primary purpose is to control the movement of animals or people and for wind protection. Live fences may also provide fuelwood, fodder and food, and may enrich the soil, depending on the species used.

Apiculture: Trees are planted at high or low density and managed and used for apiculture. Trees may be planted, established by encouraging natural regeneration, or simply left standing when the field is cleared.

Cut-and-carry fodder systems: Trees (especially legumes) are grown for fodder and managed to favour leafy biomass production. The trees are either left standing when forest is cleared for pasture establishment, planted, or established through encouraging natural regeneration.

In addition to information on agroforestry adoption, three sets of data were collected: (1) village characteristics: village land pressure, fallow length, fodder supply situation, availability of fuelwood, importance of livestock and degree of erosion; (2) farmer characteristics: age, contact with extension, family size and residency status in the village; and (3) property rights: including modes of land ownership, land rights and tree rights on the plots.

ANALYTICAL FRAMEWORK: THE LOGIT MODEL

Approaches to analising agroforestry adoption tend to follow the vast literature on adoption of agricultural production technologies, most of which focus on new or improved production inputs (Nkamleu and Coulibaly 2000). The majority of agroforestry adoption studies have relied on logit or probit models to analyse dichotomous adoption decisions in which the dependent variable is binary (Mercer 2004). In particular, they permit the interpretation of the dependent dichotomous variable as a probability. In these models, farmers are assumed to make adoption

decisions based upon an objective of utility maximisation. Under most conditions, the two models yield highly similar results[1].

The statistical analysis technique of logit regression employed in this study is described in various references, e.g. Chow (1983), Hailu (1990), Cramer (1991), Nkamleu and Adesina (2000) and Nkamleu and Coulibaly (2000). For simplicity, suppose that an agroforestry practice is represented by ‘Y’, where Y is 1 for adoption and 0 otherwise. The underlying utility function, which ranks the preference of the i^{th} farmer, is assumed to be a function of farmer-specific attributes (the vector X, which includes socioeconomic characteristics of farmers, and village-specific characteristics) and a disturbance term assumed to a zero mean. This utility function may be written as:

$U_{i1}(X) = \beta_1 X_i + \varepsilon_{i1}$ for adoption and $U_{i0}(X) = \beta_0 X_i + \varepsilon_{i0}$ for non-adoption

Because the utilities are random, the i^{th} farmer will select the alternative ‘adoption’ if and only if $U_{i1} > U_{i0}$

Thus, for farmer i, the probability of adoption of agroforestry practise ‘t’ is given by:

$$\begin{aligned} P(Y_{it} = 1) &= P(U_{i1} > U_{i0}) \\ &= P(\beta_1 X_i + \varepsilon_{i1} > \beta_0 X_i + \varepsilon_{i0}) \\ &= P(\varepsilon_{i0} - \varepsilon_{i1} < \beta_1 X_i - \beta_0 X_i) \\ &= P(\varepsilon_i < \beta X_i) \\ &= \Phi(\beta X_i) \end{aligned}$$

Here Φ is the cumulative distribution function for ε. The functional form for Φ will depend on the assumptions made about ε. A logit model arises from assuming a logistic distribution for ε. Under this assumption, for a farmer ‘i’, the probability of adoption of an agroforestry practice ‘t’ is represented as:

$$P(Y_{it} = 1) = \frac{\exp(\beta_t Z_{it})}{1 + \exp(\beta_t Z_{it})}$$

and the probability of non-adoption is given by :

$$P(Y_{it} = 0) = 1 - P(Y_{it} = 1) = \frac{1}{1 + \exp(\beta_t Z_{it})}$$

where Y_{it} is the dependent variable, which takes on the value of 1 for the i^{th} farmer adopting technology ‘t’, and 0 otherwise. β_t is a vector of unknown coefficients. Z_{it} is a vector of explanatory variables related to the i^{th} farmer and t^{th} technology.

[1] Only in rare cases, such as when there are very few negative or positive responses, do the two models produce different results.

An iterative maximum likelihood algorithm (Gourieroux 1989, Green 1992) was used to estimate the empirical models to obtain asymptotically efficient parameter estimates. The powers of the estimated models were evaluated using the percentages of correct predictions of adopters and non-adopters and Likelihood ratio test.

DATA AND EMPIRICAL MODEL

Table 1 shows the adoption patterns of agroforestry practices. The survey data reveal that 57.8% of the total sample of farmers adopted agroforestry practices. About 29% of the sample farmers adopted alley farming, adoption being most common in the Northwest and Southwest provinces. About 26% of the total sample of farmers adopted improved fallow and 27% adopted live fencing, with adoption being most common in the Northwest. Adoption of the cut-and-carry fodder system and apiculture was relatively less extensive among surveyed farmers, except in the Northwest.

Table 1. Adoption status of agroforestry practices in three provinces of Cameroon

Agroforestry practice	Northwest Province (n=341)	Centre Province (n=224)	Southwest Province (n=256)	Total (n=821)	Test of independence (Pearson χ^2)
Alley cropping	115 (33.7%)	42 (18.8%)	81 (31.6%)	238 (29%)	15.99 ***
Improved fallow	147 (43.1%)	35 (15.7%)	34 (13.3%)	216 (26.3%)	84.94 ***
Live fencing	168 (49.3)	33 (14.7%)	24 (9.4%)	225 (27.4%)	141.83 ***
Cut-and-carry fodder	127 (37.2%)	8 (3.6%)	30 (11.7%)	165 (20.1%)	111.72 ***
Apiculture	109 (32%)	1 (0.4%)	7 (2.7%)	117 (14.3%)	150.28 ***
Agroforestry[a]	280 (81.9%)	83 (36.9%)	113 (44.1%)	476 (57.8%)	141.20 ***

[a] Those using at least one of the five agroforestry practices.
*** Significant at the 1% level. Numbers in brackets are percentages of farmers using the technology in the province.

The probability of adoption of each agroforestry technology was specified as a function of the specific characteristics of farmers and villages. The descriptive statistics for the variables included in the empirical models are presented in Table 2. The dependent variable is a binary variable measuring adoption or non-adoption of agroforestry practices. It takes the value of 1 if the farmer currently uses the technology, and 0 otherwise.

Table 2. Descriptive statistics for variables used in the empirical models

Variable	Description	Continuous variable		Categorical variable(%)
		Mean	Std. Dev	
Farmers' characteristic				
SEX	Gender of the head of household. 1 = male, 0 = female			1 = 69% 0 = 31%
AGE	Age of the farmer in years.	44.5	13.88	
FHHSIZE	Household's family size.	9	5.23	
EDUC	Farmers' level of education proxy. 0 = no formal education 1 = non-formal vocational training, 2 = primary school, 3 = secondary school, 4 = post-secondary.			0 = 17% 1 = 4% 2 = 56% 3 = 19% 4 = 4%
FEXP	Farmer's years of experience.	19.39	14.56	
FAS	Measures whether or not the farmer belongs to a farmers' group. 1 = yes, 0 = no			1 = 60% 0 = 40%
CONT	Contact with extension. 1 = yes, 0 = no			1 = 70% 0 = 30%
FORIGIN	Indexes whether the farmer is a native of the village or not. 1= native, 0 = otherwise			1 = 80% 0 = 20%
SECLD	Dummy variable which indexes security of land rights. 1 = farmer has secure tenurial rights, 0 = otherwise.			1 = 50% 0 = 50%
Villages' characteristic				
AGROECO	Agroecological zone dummy. 1 = forest margin zone, 0 = otherwise.			1 = 52.5% 0 = 47.5%
VDISTOWN	Distance of the village from the nearest town (km).	2.37	1.02	
VACES	Village accessibility index. 1 = all weather tarred road, 2 = all weather un-tarred road, 3 = very difficult access.			1 = 25% 2 = 52% 3 = 23%
VEROS	Erosion index of the village. 1 = erosion is a major problem in the village, 2 = erosion is a minor problem, 3 = erosion is not a problem.			1 = 29.5% 2 = 52.5% 3 = 18%
LINC	Importance of livestock. 1 = livestock income is not important; 2 = livestock income is important; 3 = livestock income is very important.			1 = 29.5% 2 = 40.5% 3 = 30%

Although the adoption and diffusion of agricultural innovation depend on a combination of social, economic, cultural and biophysical factors, most empirical adoption work on agroforestry has tended to neglect biophysical factors such as slope, soil quality and whether the land is irrigated (Patanayak *et al*. 2003, Mercer

2004). In this study, these potential determinants of agroforestry adoption are included.

The explanatory variables in the model are: gender of the head of household (SEX), age of the farmer (AGE), family size (FHHSIZE), level of education (EDUC), year of experience in cultivation (FEXP), membership of a farmers' association (FAS), contact with extension officers (CONT), origin of farmer (FORIGIN), security of land rights (SECLD), agroecological zone (AGROECO), distance of the village from the nearest town (VDISTOWN), village accessibility (VACES), village erosion situation (VEROS), and importance of livestock as a source of income for farmers in the village (LINC). Justification for the independent variables included in the analysis and the discussion for the expected signs for their coefficients is provided below:

- SEX is a dummy variable that takes on the value of 1 if the head of household is male, and 0 if female. Some authors (e.g. Nkamleu and Adesina 2000) have argued that women are generally discriminated against in terms of access to external inputs and information. It is hypothesised that SEX is positively related to the dependent variable.
- AGE is a variable that represents the age of the farmer in years. Older farmers may be elders in the zone and have preferential access to new information or technologies through extension services or development projects that operate in the region. Also, with age, farmers accumulate more personal capital, and thus may be more likely to invest in innovations (Nkamleu and Coulibaly, 2000). However, younger farmers may be more likely to adopt new technologies or to be early adopters (Alavalapati *et al*. 1995). Young people have more energy, and investment in the long-term productivity of the soil is more important to them since they are likely to live there for a long time. Therefore, the expected sign of AGE is indeterminate.
- FHHSIZE represents a household's family size. A large family often has a large number of working members. Because agroforestry is a labour-intensive technology, the larger the family, other things being constant, the higher will be the probability of adoption (Kebede *et al*. 1990).
- EDUC represents the level of education of farmers (0 = no formal education, 1 = non-formal vocational training, 2 = primary school, 3 = secondary school, 4 = post secondary). A commonly stated proposition is that educated farmers are more likely to adopt new technologies and to be early adopters (Kebede *et al*. 1990). It is hypothesised that EDUC is positively related to the adoption of agroforestry.
- FEXP, farmer's years of experience, reflects the number of years since the respondent first began farming independently. With increasing experience, farmers may be able to make a better assessment of the differential benefits of agroforestry. Therefore, it is hypothesised that FEXP is positively associated with adoption.
- FAS measures whether the respondent belongs to a farmers' group or association and takes the value of 1 for membership and 0 otherwise. Due to the benefits of trees for sustainable land-use management, especially at the watershed levels, several agencies promoting agroforestry technologies work closely with farmers' groups. It is hypothesised that membership of a farmers' association or group increases the likelihood of adoption.

- CONT is a binary variable, which measures the contact of the farmer with extension agencies. It takes the value of 1, if the farmer has contacts with extension, and 0 otherwise. Contact with extension improves farmers' access to innovations and farm productivity. Because the use of agroforestry is more knowledge-based, farmers in contact with extension agents may be better able to manage these technologies. It is hypothesised that CONT is positively related to the adoption of agroforestry.
- FORIGIN is a binary variable, which indexes whether the farmer is a native of the village or a migrant, and takes on the value of 1 if a native, and 0 otherwise. Migrants are likely to have access to less land, and may also face restrictions on the types of land use they can practice, because they generally acquire land either through gift or renting, and may not possess land transfer rights to land. Therefore, it is hypothesised that FORIGIN is positively related to adoption of agroforestry practices.
- SECLD is a dummy variable which indexes security of land rights. It takes the value of 1 if the farmer has secure tenurial rights and 0 otherwise. Secure land rights can be from direct land purchase or divided inheritance. As tenants may be prevented from planting trees, it is less likely that agroforestry will be adopted on unsecured land. Past studies unambiguously suggest that landowners are more likely to adopt agroforestry than tenants (Patanayak *et al*. 2003).
- AGROECO is an agroecological zone dummy variable, which takes the value of 1 for farmers in the forest margin zone and 0 otherwise. Due to its low population density, land is more abundant in the forest zone than in the savanna or mixed forest and savannah zones. Land pressure is lower in forest zones, thus the probability of adoption of agroforestry will be lower. It is hypothesised that AGROECO is negatively related to adoption.
- VDISTOWN measures the distance of the village from the nearest town. Villages that are further from towns face several constraints, which limit their access to innovations. Extension agents are rarely able to reach them because of long distances, lack of operational funds and logistical constraints. Distant villages may also face lower population pressure from urban centers. The increased land availability may permit farmers to practice longer fallows. It is hypothesised that the further the village is from the nearest urban center, the lower the probability of the adoption of agroforestry.
- VACES is a variable that indexes the accessibility of the village. It takes the value 1 for an all-weather tarred road, 2 for all-weather un-tarred road, and 3 for highly difficult access. Village that have difficult access also face several constraints that limit their access to new innovations. It is hypothesised that VACES is negatively related to adoption.
- VEROS is a categorical variable that measures the extent of erosion in the village where the farmer is located. This index decreases in value the lower the extent of erosion. It takes the value 1 if the erosion is a major problem, 2 if it is a minor problem, and 3 if it is not a problem. Because agroforestry has been shown to help reduce runoff (Kang *et al*. 1995), villages with erosion problems would have an incentive to adopt alley cropping (Patanayak *et al*. 2003). It is hypothesised that VEROS is negatively related to adoption.
- LINC measures the importance of livestock as a source of income for farmers in the village and increases in value as livestock income becomes more

important. It takes the value of 1, if livestock income is not important, 2 if it is important, and 3 if is highly important. As the importance of livestock income increases, farmers can be expected to be more interested in seeking appropriate sources of fodder. It is hypothesised that LINC is positively related to the adoption of agroforestry practices.

EMPIRICAL RESULTS

Six logit models have been estimated to predict the probability of adoption of the six agroforestry systems. Model results are presented in Table 3. Altogether, 11 of the 14 variables included in the models have significant effects in explaining the adoption decisions.

SEX has a positive effect on the adoption of live fencing, apiculture and agroforestry technologies, at the 1% significance level. This suggests that men are more likely to adopt those agroforestry practices.

Household family size is positively and significantly related to farmers' adoption of live fencing and apiculture. This indicates that larger families with increased labour supply are more likely to adopt the technologies than smaller households.

The positive and significant sign of EDUC on apiculture indicates that educated farmers have greater likelihood of adopting this practice.

Farmers' experience (FEXP) positively and significantly influences the adoption of improved fallow, suggesting that the higher the level of experience, the greater the likelihood of farmers using improved fallow.

As expected, membership of associations (FAS) positively and significantly influences the adoption of all of the agroforestry practices.

The significance of CONT on alley farming, improved fallow and cut-and-carry fodder technologies suggests that contact with research and extension is critical for the successful adoption of those technologies.

Security of land tenure, SECLD, positively and significantly affects the adoption of improved fallow and, contrary to expectations, this variable is negatively related to the adoption of live fencing, implying that the probability of adoption of live fencing is lower when ownership on land is secure. This suggests that people invest in land (particularly in live fencing and improved fallow) to make their land rights more secure.

Agroecological zone (AGROECO) is negatively related to the adoption of improved fallow, live fencing, cut-and-carry fodder, apiculture and pooled agroforestry techniques As expected, the probability of adoption of agroforestry practices is lower in the forest margins. The relative long fallow periods in the forest zone, availability of high levels of biomass from forest vegetation, and farmers' general perception that soil fertility is not yet a major problem, reduce the probability of adoption of agroforestry practices.

Table 3. Logit models for agroforestry technologies in Cameroon

Variable	Coefficient					
	Alley cropping	Improved fallow	Live fencing	Cut and carry fodder	Apiculture	Agroforestry
Constant	-3.5098 *** (-3.906)	-5.027 (-5.153) ***	-2.1484 (-2.38) **	-1.7503 (-1.689) *	-4.4523 *** (-3.196)	-0.71182 (-0.871) ***
Farmers' characteristic						
SEX	7.20E-02 (0.293)	0.28845 (1.162)	1.1042 (4.365) ***	0.26087 (0.97)	1.3924 *** (4.11)	1.0389 *** (4.028)
AGE	5.36E-03 (0.548)	-1.52E-02 (-1.494)	-1.16E-03 (-0.119)	4.36E-03 (0.404)	1.26E-02 (1.007)	-9.22E-03 (-0.89)
FHHSIZE	-5.20E-03 (-0.279)	-3.91E-03 (-0.217)	1.13E-02 (0.607) ***	5.96E-03 (0.302)	4.11E-02 * (1.825)	3.30E-02 (1.507)
EDUC	5.90E-02 (0.538)	8.98E-02 (0.802)	0.11718 (1.06)	0.17846 (1.47)	0.37396 *** (2.543)	4.84E-02 (0.415)
FEXP	-4.34E-03 (-0.473)	2.00E-02 ** (2.077)	1.21E-02 (1.287)	1.12E-02 (1.092)	-5.91E-04 (-0.05)	1.58E-03 (0.161)
FAS	1.4848 *** (5.871)	1.0119 *** (4.279)	0.52856 (2.319) **	1.1706 (4.094) ***	0.9448 *** (2.737)	1.0527 *** (5.053)
CONT	2.1735 (6.173) ***	0.86929 (3.45) ***	0.19855 (0.835)	0.65045 (2.279) **	0.25454 (0.753)	1.3174 *** (5.399)
FORIGIN	6.48E-02 (0.243)	0.12273 (0.419)	-0.13255 (-0.475)	-0.48186 (-1.598)	-0.35327 (-0.894)	-0.37852 (-1.376)
SECLD	1.19E-02 (0.061)	0.41906 ** (2.12)	- 0.3503 (-1.795) *	0.17426 (0.797)	0.17119 (0.66)	8.81E-02 (0.447)
Villages' characteristic						
AGROECO	-0.3815 (-1.019)	-1.8026 (-4.68) ***	-1.7357 (-4.681) ***	-2.1084 (-5.079) ***	-4.0969 *** (-6.777)	-2.3371 *** (-5.78)
VDISTOWN	3.81E-02 (0.347)	0.62657 (5.031) ***	7.12E-03 (0.063)	5.09E-02 (0.425)	0.1846 (1.209)	0.2797 ** (2.219)
VACES	-0.13502 (-0.886)	0.15004 (0.98)	0.27644 (1.78) *	-0.24852 (-1.415)	0.23014 (1.072)	-3.07E-02 (-0.2)
VEROS	-0.10839 (-0.489)	0.22421 (0.993)	-0.22082 (-0.993)	-0.15338 (-0.603)	2.79E-02 (0.09)	-0.32819 (-1.497)
LINC	4.60E-03 (0.026)	0.5103 *** (2.835)	0.16509 (0.939)	-4.36E-02 (-0.224)	-0.12805 (-0.557)	0.30349 * (1.643)
	Log-Likelihood = -324.80 Chi-square = 159 *** Sample = 676 Percentage of correct prediction = 74%	Log-Likelihood = -325.13 Chi-square = 166.63*** Sample = 675 Percentage of correct prediction = 77%	Log-Likelihood = -332.64 Chi-square = 154.06*** Sample = 676 Percentage of correct prediction = 76%	Log-Likelihood = -273.05 Chi-square = 156.75*** Sample = 676 Percentage of correct prediction = 81%	Log-Likelihood = -196 Chi-square = 208.51*** Sample = 676 Percentage of correct prediction = 86%	Log-Likelihood = -325.91 Chi-square = 263.01*** Sample = 678 Percentage of correct prediction = 77%

*** Significant at 1%; ** significant at 5%; * significant at 10%. Figures in parentheses are t-values.

VDISTOWN positively and significantly affects the adoption of improved fallow. This result is contrary to expectation. This implies that the farther the village is from an urban centre, the higher the likelihood of a farmer's adoption of improved fallow. Fallow practices are more common in villages far from urban centres, which would make adoption of a fallow-based technology easier for farmers from those villages.

Village accessibility (VACES) positively and significantly affects the adoption of live fencing, while livestock income (LINC) is positively related to adoption decisions about improved fallow and pooled agroforestry.

CONCLUSIONS

With population growing at 3% annually and the rapid conversion of tropical forests, one of the key challenges of the future is to undertake research on sustainable agricultural systems as alternatives to unsustainable slash-and burn practices in various parts of SSA. There is considerable scope for the research and extension service to assist farmers in developing appropriate alternatives to slash-and-burn. This will require a reorientation of research efforts towards an increased focus on site-specific conditions, on long-term research and on cropping systems and practices used by farmers. In particular, quantitative analysis of the determinants of adoption decisions of farmers is needed to help in the better targeting of technologies into areas where potential adoption is likely to be greater.

The analysis reported in this paper demonstrates that the factors affecting farmers' adoption of various agroforestry practices are not necessarily the same between agroforestry practices, and generalisation should be avoided. The results have a number of implications for strategies to promote agroforestry among farmers in Cameroon. Policy-makers need reliable information on the likely effects of various socioeconomic variables on the adoption or rejection of a technology. This study has identified factors that significantly affect the adoption of agroforestry practices; these include gender of farmers, household family size, level of education, farmers' experience, membership within farmers' association, contact with research and extension, security of land tenure, agroecological zone, distance of the village from nearest town, village accessibility and livestock income. Extension efforts should take these factors into consideration to target agroforestry technologies more efficiently within farmer populations.

Further research should continue to carry out such empirical studies for other sustainable agricultural systems. The best-bet alternative to slash-and-burn probably will not refer to a single land-use system or technology, since the most attractive way to achieve the various objectives is likely to come from a combination of complementary land-use practices in a particular spatial context. Future research is needed to quantify the contribution of agroforestry to household income, food security and welfare.

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